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**APOLLO MONTHLY PROGRESS REPORT**  
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NAS9-150

March 1, 1965



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## TECHNICAL REPORT INDEX/ABSTRACT

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## ABSTRACT

Brief illustrated narrative report of Apollo program progress for the period, highlighting accomplishments, milestone achievements, and a continuing summary of the program

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## PROGRAM MANAGEMENT

## STATUS SUMMARY

After stacking and alignment of the command and service modules of boilerplate 22 on January 15, the service module was transferred to the static test tower (building 450). The command module, service module, and launch escape subsystem were stacked on January 17 (Figure 1). Boost protective cover installation was then completed, and a design engineering inspection (DEI) was conducted on January 19. Power-on tests were accomplished after the conclusion of the DEI.

The fourth (and final) service module reaction control subsystem panel for spacecraft 006 was completed on January 18.

The compatibility checkout of the launch escape subsystem-earth landing subsystem and the ground support acceptance checkout equipment was completed on boilerplate 14 (house spacecraft 1) on January 25.

The second drop of boilerplate 28 was conducted on January 29 at the Downey water impact test facility. The boilerplate vehicle sustained no structural damage. The second successful test (test 3) was conducted on February 9.

The first hot firing of the service propulsion subsystem engine in the service module of spacecraft 001 was accomplished on schedule on February 5. The White Sands firing lasted the required 10 seconds. An earlier firing on the same day was terminated by vibration cutoff.

After NASA acceptance of the guidance and navigation secondary structure installation on February 12, all of the interior secondary structure bays in the command module of spacecraft 009 were completed.

The third of the three General Electric spacecraft acceptance check-out stations came "on line" during the report period.

## SCHEDULE REVISION

The Block I schedule was revised on January 22 as a result of discussions between NASA and S&ID with particular emphasis upon redefinition of the ground test program. Most of the changes represented additional program adjustments in support of Contract Change Authorization 272,

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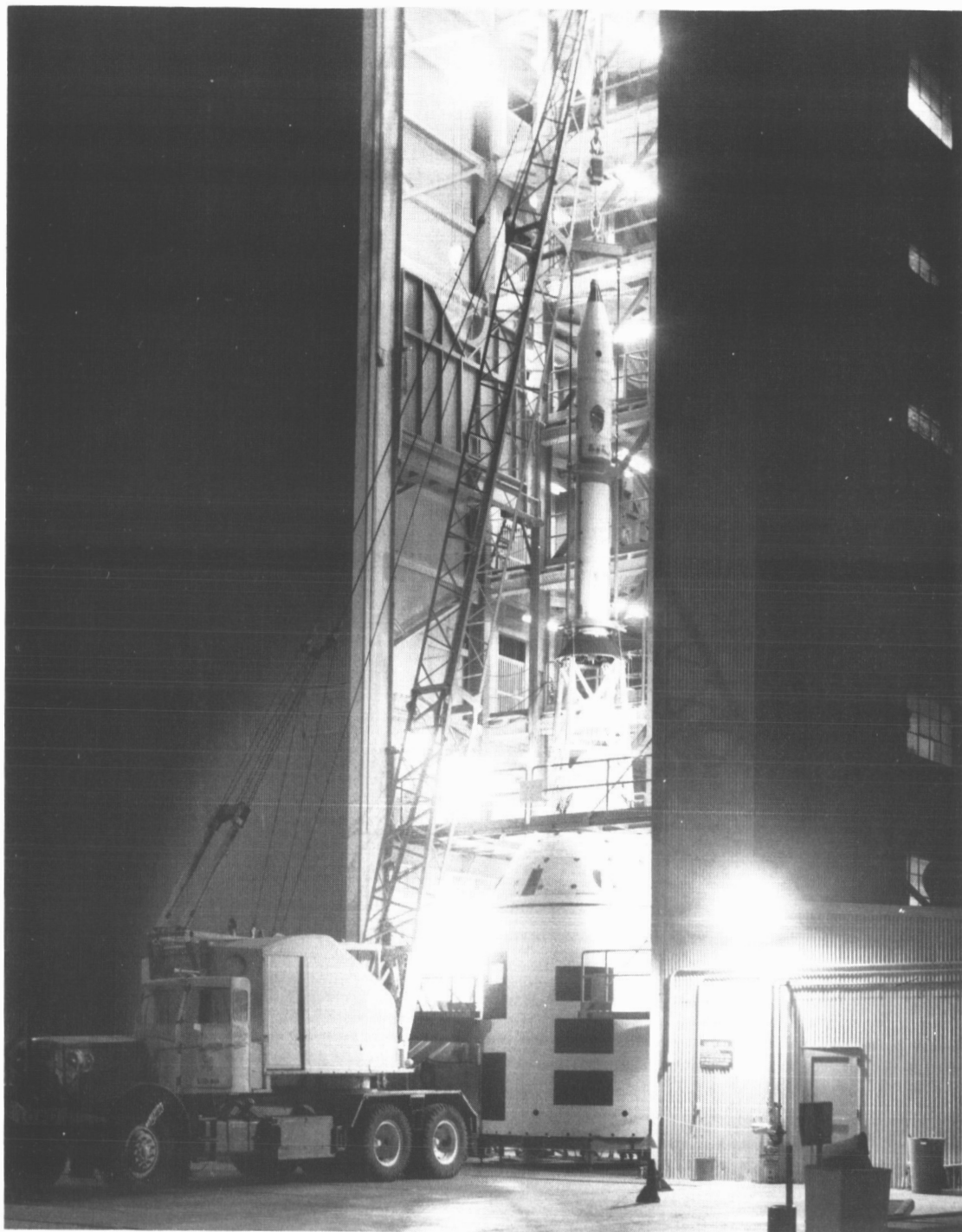


Figure 1. Boilerplate 22 in Static Test Tower, Downey

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dated November 25, 1964. The major changes in the revised schedule include the acceleration of the shipment and launch of boilerplate 22, the increased test time for spacecraft 004, the extension of the quality verification vibration test (QVVT) program for spacecraft 006, the updating and use of boilerplate command module 18 with spacecraft 015, the revision of the shipment date of spacecraft 020, and the revision of the test program of boilerplate 14 to accelerate guidance and navigation testing.

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## DEVELOPMENT

## SYSTEM DYNAMICS

Aerodynamics

The wind tunnel test data report for the force and moment test of the Block I FS-2 model at the Ames Research Center was completed. Data were obtained for the launch escape vehicle with canards in the subsonic Mach number range for angles of attack from 0 to 300 degrees and roll angles of 0, 30, and 60 degrees. The Block II version of the FS-2 model is scheduled for testing in the Ames unitary plan wind tunnels to determine the primary trim limit line and the trim aerodynamic characteristics for the command module with blunted apex cover. Force and moment data will be obtained for Mach numbers from 0.7 to 3.4 in the 0- to 180-degree angle-of-attack range.

Pyrotechnics and Earth Landing Subsystem (ELS)

The dual drogue disconnect cutter assemblies passed acceptance tests, with the test firings made against titanium test plates. Constraint tests for boilerplates 6A and 19 were completed successfully. Four cutter assemblies were delivered to El Centro to support the boilerplate 19 drop test.

Development testing of the proposed guillotine-type cutters, designed to separate the umbilical by direct action, are continuing. Results indicate that detonating the explosive train from the center is desirable. The design is being modified to provide for center detonation of each explosive train.

Detailed analysis of parachute canopy failures experienced in recent drop tests is continuing. Special attention was directed to the development of improved packing techniques, and future main parachutes will be reinforced to provide a better safety margin. Two parachute drop tests were completed during this report period. Drop 77, conducted at El Centro, successfully demonstrated the structural integrity of the reefed drogue system. Drop 78 disreefed late, resulting in only a 32,600-pound load. Another test is scheduled to achieve the ultimate load of 34,800 pounds.

Preliminary design was completed on the single-point attachment between the docking probe and the boost cover shroud of the command module. This device allows the pull-away of the docking subsystem during abort conditions up to 250,000 feet. A passive tension tie with shear pin installation proved to be the lightest configuration.

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## MISSION DESIGN

A study was conducted to investigate the use of existing system capabilities to furnish an earth pointing reference for the high-gain antenna subsystem. The need for this study was indicated by the requirement for an external pointing reference prior to initiation of infrared (IR) tracking and because of the approximately 400 earth acquisitions required for a typical lunar mission. Six separate techniques for obtaining and using the earth pointing reference were investigated:

- IMU line-of-sight, manual
- IMU line-of-sight, direct
- IMU line-of-sight, automatic
- Inertial hold
- Optics line-of-sight
- MSFN data

This analysis included the effects on earth acquisition of astronaut performance, system errors, vehicle roll rate, IR beamwidth, system reliability, and sun-vehicle-moon-earth geometry. These effects were modeled to measure the following factors:

- The probability of IR earth acquisition
- Acquisition time
- Electrical time
- Required astronaut support

Several of the earth-pointing techniques require the use of an automatic guidance computer (AGC) subroutine for computation of the earth pointing vector. Although the subroutine is presently being implemented by NASA for an accuracy of  $\pm 5$  percent, the study indicated the desirability of an accuracy of  $\pm 1$  percent.

A short study was conducted to estimate the maximum mission duration capability of the manned Block I spacecraft. The effort was started in response to increasing concern at NASA and S&ID relative to the capability of the Block I spacecraft to fly long-duration development missions.

The study was based on a hypothetical mission embodying a nearly circular orbit having an initial apogee of 180 nautical miles and an initial perigee of 105 nautical miles. It was assumed that the Saturn IB would be capable of inserting the spacecraft directly into orbit by providing an over-velocity of approximately 135 fps at the normal Saturn IB insertion altitude of 105 nautical miles. Electrical power and service module propellants were conserved by not allowing service propulsion subsystem (SPS) maneuvers other than deorbit. The guidance and navigation was turned off for the entire

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mission, and the stabilization and control subsystem (SCS) was placed on stand-by intermittently to reduce the electrical power load. The average total power level for 98 percent of the mission was approximately 1730 watts.

On the basis of the assumptions made, a mission duration of 13.4 days appears possible. Calculations indicated that fuel cell reactants would be exhausted at the end of this time. Under the conditions of the low electrical power level and the maintenance of favorable attitudes, the environmental control subsystem (ECS) water boil-off consideration did not appear to constrain the mission. It should be emphasized, however, that the addition of development operations and maneuvers is expected to decrease the mission duration capability.

#### CREW SYSTEMS

The responsibility of preparing the production design and manufacturing the crewman optical alignment sight (used for docking) was assigned to Autonetics. The dual mount and the  $\pm 10$ -degree elevation adjustment of the sight were incorporated in the procurement specification. A new proposed reticle pattern (recommended by the astronauts) was submitted by NASA for S&ID review. The new reticle design has been incorporated into the specification. S&ID provided alignment sight detail and installation drawings to Honeywell in support of their scheduled manual thrust vector control (TVC) simulation.

#### STRUCTURAL DYNAMICS

Flotation tests using tenth-scale models of the command module were conducted at Stevens Institute from January 25 through February 5. Basic objectives of the tests were to determine command module righting moments, static properties, and response to random waves, and to evaluate command module flotation characteristics in various sea states with and without uprighting aids. The sequence in which the uprighting bags were inflated was found to be as critical for random wave conditions as that sequence previously determined experimentally for calm sea conditions. In order to shift the vehicle from the second stable position (on its side) to the first stable position (upright), the two bags on the Y-axis must be inflated before the Z-axis bag is deployed; failure to follow this sequence results in the vehicle assuming the third stable position (apex down). Predictions that wave action would shift the command module from the third stable position to the upright position were not confirmed in any of the tests. Test data from this series of tests are being evaluated.

The quality verification vibration test (QVVT) plan was modified to conform to Master Development Schedule 8, revision 2. Three weeks have been allocated for the QVVT tests on spacecraft 006, including the time

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required for vehicle installation and removal, instrumentation installation and checkout, shaker attachment, and other nontest operations. An effort is being made to develop a satisfactory test envelope for the relatively short time available for tests on spacecraft 006. Based on this test experience, test programs will be prepared for flight spacecraft beginning with spacecraft 009. Differences in inertia and elasticity between spacecraft 006 and the various flight vehicles are being studied. An acoustical survey of building 290 was conducted to assess probable noise transmission characteristics during the vibration tests and to select damping material for test-fixture pedestals, columns, and support rings. Delivery of shaker equipment is being expedited to meet the QVVT test schedule.

## STRUCTURES

Two water drops of boilerplate 28 were made with bonded doublers added to the aft heat shield to represent spacecraft 009 configuration. Data are being evaluated; the resultant deformation in the toroidal area of the heat shield is being investigated.

The qualification program for the Allison SPS propellant tanks is considered successfully concluded. The last (sixth) qualification fuel tank was successfully burst at 452.5 psig; the design burst pressure is 360 psig.

Five qualification units of the 40-inch helium pressure vessels for the service module propulsion subsystem completed all tests. Qualification units 3 and 4, however, failed burst tests; a sixth (final) vessel, therefore, will be run through all the tests that were originally assigned to qualification unit 4. The two failed units ruptured in the weld area, apparently as the result of stress concentration (fatigue due to excessive cycling) in that area. During this report period, qualification units 2 and 5 were successfully burst at 7175 psig and 7350 psig, respectively. Design burst pressure is 6600 psig. Qualification tank 5 was burst, following rework of the exterior weld bead (to relieve stress concentration) and after a third proof-pressure cycle (5500 psig for 3 minutes and 1500 cycles from 0 to 4400 psig), a helium leak check, and vibration testing. The removal of the exterior weld bead appears to have removed the cause of the two previous failures.

## GUIDANCE AND CONTROL

All Block I and eight Block II electrical interface control documents (ICD) were completed and transmitted to MIT for review. The Block II guidance and navigation wiring schematic was completed in preliminary form. The procurement specification for the entry monitor subsystem (EMS) is being prepared for transmittal to Autonetics. Autonetics will design, develop, and fabricate the EMS.

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A preliminary analysis of stability boundaries for capture latch was completed. Capture latch is considered to occur between the two docking space vehicles when the probe head of the docking mechanism reaches the apex of the drogue and is automatically latched into place. Stability boundaries are defined as those combinations of closing and radial velocities, miss distance, angular misalignment, and angular velocity at initial contact, which, if exceeded, will cause the docking subsystem to fail to achieve capture latch. Results from a two-dimensional mathematical model indicate that a combination of low relative closing energy and a 12-inch miss distance precludes achievement of a successful capture latch. Adding energy after initial contact by service module RCS thrusting, however, permits successful capture latch for all docking contact conditions specified in "CSM Technical Specification" (SID 64-1344).

A study of the pointing accuracy requirements for transearth injection is being conducted. The purpose of the study is to determine if a reduction of accuracy requirements during transearth injection is warranted because of a change in entry-survival-corridor size. Preliminary study has shown that the design requirements should be based on an SCS  $\Delta V$  mode for transearth injection and midcourse phase while navigation is being performed by the MIT optical system. Tradeoff analysis is in progress to determine the  $\Delta V$  penalty due to variation of pointing accuracy for satisfying the required entry corridor. Results of the analysis will be used to establish a subsystem  $\Delta V$  error budget from which design requirements can be established.

The control programmer breadboard is being checked out at S&ID in preparation for interface testing with block "J" SCS configuration. The interface testing will provide verification of electrical, functional, and fixed-base, open-loop performance of a major portion of the combined guidance and control hardware required for spacecraft 009.

System configuration has been defined for operational hardware and software requirements, simulation studies, and all interface equipment. Approximately 75 percent of the detailed design work has been completed.

## TELECOMMUNICATIONS

### Communications

The up-data link equipment for spacecraft 006 was acceptance-tested at Motorola and delivered to S&ID. This unit will be available for checkout of the up-data link portion of bench maintenance equipment until required for installation on spacecraft 006.

EMI testing of the flight-qualification recorder was completed by the Leach Corporation; the unit is being prepared for delivery to S&ID. The equipment has 14 channels for onboard recording of flight data.

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Results of pulse code modulation (PCM) testing by the Apollo Telecommunications Engineering Evaluation facility indicate that proper PCM synchronization can be achieved by the ground telemetry station with the Apollo spacecraft. This conclusion is based on tests using simulated data inputs for spacecraft 009.

Collins Radio reported that the gold plating on the multiplexer unit was flaking off under salt spray tests. Plans are being implemented to replace the gold plating with aluminum irridite plating to eliminate this problem. The multiplexer is designed for Block I spacecraft and is to be used with all VHF telemetry and voice equipment and the VHF up-data equipment.

The initial draft of the procurement specification for the Block II S-band antenna was completed. This completely new and smaller antenna will be flush-mounted in the command module for voice, telemetry, and up-data communications during near-earth flight.

Contract negotiations were completed on February 11 with Dalmo-Victor for the procurement of the Apollo high-gain antenna.

#### Instrumentation

The "Instrumentation Subsystem Development Plan" (SID 64-2061) is being published. The breadboard assembly of the instrumentation subsystem for spacecraft 009 was completed. Engineering evaluation tests using the breadboard were begun February 15 to determine the compatibility of the hardware comprising the flight qualification instrumentation subsystem.

Qualification tests of 14 types of sensors were completed by the supplier during this report period; qualification tests of 6 other types are under way.

Block II measurement requirement lists were published for house spacecraft 2H-1 and thermal vacuum spacecraft 2TV-1. The Block II list for flight-operational vehicles has been approved for release.

#### ENVIRONMENT CONTROL

Actual heat rejection values obtained during a cold chamber test of the spacecraft 012 radiator were found to be in close agreement with values predicted by S&ID. A slight change in the radiator design is being incorporated to prevent the possible freezing of the outside tube. Results of the test and the corresponding analytical computer runs were transmitted to MSC.

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A redesign of the command and service module umbilical separation system was initiated, and suggested structural changes were identified. These changes would reduce the thermal conductance between the separation system and the command and service module fairing to approximately five percent of the existing value.

A thermal analysis was completed for spacecraft 009. With an ablator thickness of 0.85 inches, the maximum bondline temperature of the windward tower leg wells is expected to be 590 F (600 F allowable). The command module steam vent was shown to be thermally sound in design; it does not require additional insulation. Detailed temperatures were obtained for the undershoot trajectory that causes an inflow of hot plasma into the vent; the aluminum portion of the vent is expected to reach 295 F during this period. Temperatures for the components in the command module forward compartment (main parachutes, drogue chutes, pilot chutes, and ordnance devices) were shown to be within allowable operating limits. Heating rates on the main chutes after apex cover jettison and during recovery are also within limits, reaching a maximum of 0.6 Btu/sq ft/sec.

#### ELECTRICAL POWER

The qualification test program for the oxygen surge tank was completed. Four tanks successfully passed all phases of testing.

An integrated fuel cell subsystem test was performed at S&ID, including startup operation with the power distribution breadboard, actuation of the service module RCS gimbal motors, and load sharing with a GSE power supply and spacecraft batteries. A short-circuit test was also performed. Data accumulated during this test are being analyzed.

The average power profile for a Block II mission, as requested by NASA, was completed, using a time line of 8.28 days. The total energy required is 317.2 kilowatt-hours, plus 15.8 kilowatt-hours for the lunar excursion module. This analysis did not include the instrumentation subsystem.

The GSE/electrical wiring-cabling interface matrix was completed. The matrix identifies all wiring interfaces between the stack and GSE by vehicle and by facility.

The results of the oxygen tank heat leak test show that an insulation vacuum of  $1 \times 10^{-5}$  mm Hg or better is required to maintain heat leak values within specification limits. The oxygen and hydrogen relief couplings successfully passed temperature and operating life tests but failed to meet leakage requirements after exposure to thermal shock during qualification testing. Proposed corrective action is being prepared by the supplier.

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An acoustic test was completed, using an unpotted inverter and external acoustic abatement materials. The basic unit exhibited an overall acoustic noise level of 59 decibels, averaged over a frequency span of 400 to 40,000 cycles. These acoustic abatement materials were tested individually and in combination. With damping material alone, the noise level was reduced 0.5 decibels. A combination of damping material, felt, and fiberglass reduced the noise level by 8.9 decibels.

An analysis of test data obtained from simultaneously operating three fuel cells in a vacuum indicates that the heat loss to the surrounding structure is 576 Btu/hr per fuel cell. After heat loss fixes are incorporated in production fuel cells by Pratt & Whitney, it is estimated that fuel heat losses in the flight configuration will be approximately 250 to 300 Btu/hr per fuel cell.

## PROPULSION

### Service Propulsion Subsystem

The Series I program tests on the service propulsion subsystem (SPS) engine test fixture F-2 were concluded. During the 28 tests, 775 seconds of operation were accumulated. Phase II of the simulated high-altitude engine test program continued with seven firings. The chamber pressure survey was satisfactorily completed. During this report period, 122 firings were made at Aerojet-General on two engine assemblies; 12 of these firings were with propellants at 140 F.

### Reaction Control Subsystem

A meeting was held on January 21 between S&ID and Stratos, following a comprehensive design review of the Stratos RCS pressure regulator. The design and process changes being incorporated to assure proper and repeatable assembly of units were outlined. Tests were conducted on January 22 and 23 on regulators (engineering test units that will be used for propellant compatibility testing). The design changes for the regulators were incorporated, and they were assembled to the new processes. The results of the tests are well within specification requirements. Detail parts were released for assembly of production units.

Flex hose qualification and off-limits test programs were successfully completed, and test reports were submitted to S&ID for review. The fluid compatibility development test of the service module relief valve was completed satisfactorily on January 25.

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Data obtained by Rocketdyne during the command module RCS engine injector screening test indicate that the redesigned injector (removal of the chamfer on the oxidizer orifice inlets) will provide engine performance in excess of specification requirements.

A hot firing test was conducted on the command module Phase II breadboard on January 20. This test used a mission duty cycle, simulating dual system operation. The duty cycle duration was approximately 32 minutes. The test consisted of system activation, engine calibration, preentry and entry firing modes, and propellant burn to depletion. The command module RCS breadboard Phase II pad abort propellant dump test was conducted on January 27. Test data are being evaluated.

#### Launch Escape Subsystem

A tower jettison motor was static-tested on February 2 at 140 F after temperature cycling. This was the fourteenth qualification test conducted and the third initiated with a single igniter cartridge. A review of the test results indicates an unusually long ignition delay, but, once ignited, the motor performed satisfactorily. The cause of the ignition delay is being investigated by Thiokol. Vibration testing of the four tower jettison motors at United Aerotest Laboratories was completed on January 31. No abnormality was noted.

#### Propulsion Analysis

Complete determination was made of the propellant and helium weights needed to size the Block II SPS propellant tanks and helium bottle. This information will be used to determine propellant tank sizes and helium bottle thickness. Evaluation was made of the possibility of an overpressure upstream of the pilot valves of the SPS pneumatic propellant valve actuation system because of regulator leakage. An analysis of the actuation system indicates that the incorporation of a pressure relief valve downstream of the pressure regulator is warranted.

The minimum temperature of the command module RCS engine valves for Block II vehicles during transearth flight, with a depressurized cabin, has been determined to be minus 25 F. This temperature is below the oxidizer freeze point, and functional engine operation indicates that thermal control must be considered.

In a meeting with NASA at MSC on January 22, problems were discussed in connection with flying an instrumented service module RCS package on boilerplates 26 and 9 to obtain boost-heating information.

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## GROUND SUPPORT EQUIPMENT

The final engineering changes were completed for the electrical terminal distributor for boilerplate 22.

The manufacturing and acceptance of the data acquisition adapter are complete pending NASA approval of the end-item process specification. The digital signal conditioning and multiplex unit and the analog signal conditioning and sampling unit were also accepted by NASA during this report period.

A study was completed of the schedule effect on the spacecraft acceptance checkout equipment (ACE) system if the system performs the functions of the service module RCS propellant gauging checkout equipment. It was determined that additional hardware design would be required to implement ACE.

The second source supplier evaluation for the ACE command system was completed and presented to NASA. NASA approved the second source and gave the approval to proceed with the contract award on a fixed-price basis.

A dry run was completed of the first-article demonstration (FAD) on the flight pulse code modulation packages. NASA-MSD personnel witnessed the dry run which encompassed approximately 8650 individual tests. NASA-MSD expressed satisfaction with the FAD. Spacecraft instrumentation test equipment and bench maintenance equipment (Figure 2) are capable of supporting bench maintenance tests on the flight PCM packages. Preparation is now under way for the FAD on the flight data storage equipment and ACE system configurations.

## SIMULATION AND TRAINERS

A total of 46 production runs were completed during this report period for the attitude modes phase of the mission evaluation 009 study. Production runs for the second phase (automated systems) and the third phase (entry modes) were also completed.

Significant developments in the mission evaluation 011 study include the completion of preliminary and breadboard development of the pulsed integrating pendulous accelerometer logic, fabrication of the logic for the IMU digital modulators, and completion of the ground monitor console panels.

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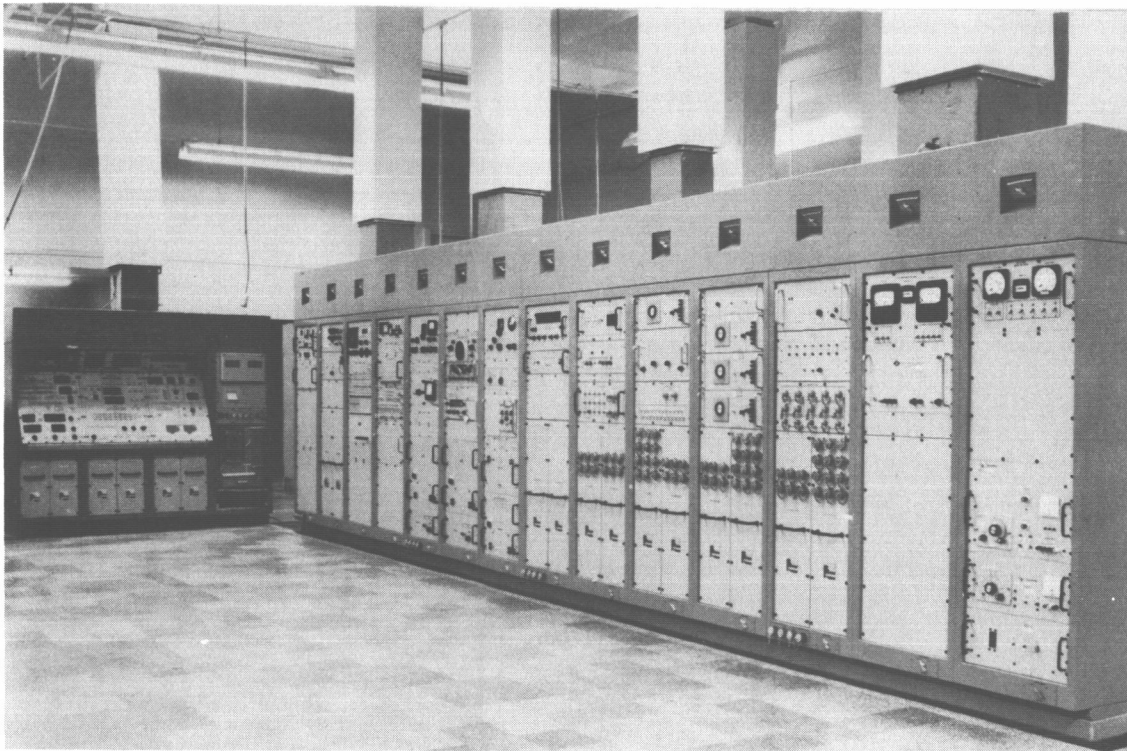
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Figure 2. Spacecraft Instrumentation Test Equipment (SITE) and Bench Maintenance Equipment

A meeting of NASA, S&ID, and Link was held at Downey to resolve quality control, installation, and checkout plans for the Apollo mission simulator.

#### VEHICLE TESTING

The flight-type helium panel was installed on the F-2 fixture at PSDF. The propellant feed lines and flow meters had been previously calibrated using actual propellants. The thrust chamber on the SPS engine was replaced, and the interim fire console and associated cables were replaced with updated hardware. The first of eight tests in the series II static firing began February 10. This series is a continuation of the SPS development tests, including the first gimbaling tests in support of spacecraft 001.

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Two successful water drops of boilerplate 28 were made during this report period. Drop 91 on January 29 tested the aft heat shield with bonded doublers at maximum limit loads; all objectives were met. The second test, drop 92, on February 9, was made to meet the following objectives:

1. Exceeding the calculated heat shield core shear capability without leakage
2. Investigation of the plastic behavior of the toroidal section under conditions more severe than in drop 91
3. Achievement of a nominal two-chute descent rate
4. Provision for a meaningful projection of existing impact data

Visual observation and preliminary analysis of photographic coverage of the drop indicated that the above objectives were met satisfactorily. Drop conditions were met as follows:

$$V_N \text{ (normal velocity)} = 33.5 \text{ fps}$$

$$V_T \text{ (tangential velocity)} = 36 \text{ fps}$$

$$\text{Pitch} = -19 \text{ deg}$$

$$\text{Roll} = 180 \text{ deg}$$

During this report period, modifications of boilerplate 14 were nearly completed. The primary modification was the installation of the sequencer subsystems and their associated harnesses. Installation of the harnesses was completed in the last period; the last of the sequencers was installed on January 26. Modifications to ACE-SC models were also completed to make ACE-SC for boilerplate 14 similar to that of spacecraft 009. Preparations required to support initial sequencer checkout are complete. Apollo test requirements, ACE-SC tapes, and development test procedures were completed in preparation for initial sequencer checkout and the second series of integrated tests.

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## RELIABILITY

Reliability analysis supported a proposal to improve the water impact characteristics of the command module by increasing the parachute hang angle. Subsequent boilerplate 28 water impact tests, simulating spacecraft 009, substantiated the feasibility of the proposed change.

As a result of the launch escape qualification review held January 5 at NASA-MSC, S&ID performed a reliability assessment concerning actual mission abort requirements that included a value established for the roll moment performance of the launch escape motor. The assessment disclosed that this parameter does not contribute significantly to the probability of motor failure. Therefore, there is no change in the S&ID recommendation that the Lockheed launch escape and pitch control motors be considered qualified.

A series of meetings between S&ID and NASA were held at S&ID during this report period to complete qualification, breadboard, integrated, and mission-support test requirements. Major developments of the meetings included the following:

1. Review of NASA-MSC comments on the test program guidelines and ground rules
2. Development and documentation of the rationale upon which the qualification rigor is based
3. Definition of the rigor to be imposed on applicable portions of design verification tests, breadboard, and system tests for qualification purposes.

Apollo Reliability recommended that a solid-state relay configuration, consisting of four switching transistors and a series pair of relay contacts, be used to eliminate the earth landing sequence controller single-point failure. The recommended change is being incorporated in Block I flight vehicles, beginning with boilerplate 22.

The cause was determined for a major calibration problem in micro-system temperature transducers, and corrective action was taken.

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## SPACECRAFT DEVELOPMENT ANALYSIS AND INTEGRATION

To date, 31 percent, or 242, of the Apollo program interface control documents (ICD) have been accepted by S&ID, NASA, and/or the concerned associate contractor. Table 1 shows a status summary of all ICD's which have been identified for the Apollo program.

The design subpanel for the emergency detection subsystem (EDS) held a meeting at MSC in mid-January. Agreement was reached on a change to the EDS automatic abort, enabling circuitry in the master event sequence control for incorporation in the Block I spacecraft. A change to the liftoff signal circuitry in the launch vehicle instrument unit (IU) was also agreed to for incorporation in all Saturn launch vehicles that will carry Block I spacecraft. The purpose of these changes was to eliminate single-point failures. The changes involved have already been incorporated by NASA-MSFC and S&ID, with minimal schedule impact. A joint NASA-S&ID test requirement review was completed in January. The purpose of this review was to restate and confirm baseline logic and programming of Apollo testing networks and to organize subsystem test models with plans and requirements for end-item vehicles. Tests fulfilling logic networks for vehicle certification were identified to distinguish them from total Apollo tests. The review was conducted in two phases, with the first phase occurring in early January. Thirteen subsystem working teams collected data and prepared drafts of vehicle test matrixes. After special joint studies with NASA were conducted, areas of disagreement were resolved, and drafts of composite vehicle books were compiled for spacecraft 009, 011, and 012. During the second phase, the results of the special studies and a summary of subsystem tests, including changes, deviations, and impacts, were presented to a joint NASA-S&ID review board. Plans and proposals presented in a briefing to NASA and S&ID management were accepted without change. Formalization of test documentation for spacecraft 009, 011, and 012 has been started.

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Table 1. Interface Control Documents

Interface Area	No. Identified	No. Not Started	No. in Work	No. Signed by S&ID NAA Only	No. Signed by NASA and S&ID
Grumman (LEM airborne)	77	27	33	11	6
Grumman (airborne common use)*	0	0	0	0	0
Grumman (GSE common/concurrent use)*	49	5	13	24	7
MIT (G&N, airborne)	101	41	28	11	21
MIT (G&N, GSE)	31	15	5	2	9
D. Clark (Block I space suit)	16	3	12	1	0
Hamilton Standard (Block II space suit)	22	7	14	1	0
NASA (trainers and simulators)	28	12	15	1	0
NASA (GFE, crew systems and sciences)	26	0	24	2	0
NASA (GSE/facility)	224	18	19	44	143
NASA (Saturn launch vehicles)	198	141	9	0	48**
Convair (LJ-II launch vehicles)	11	2	1	0	8
Total	783	271	173	97	242
*ICD use to be discontinued when CEI or critical component specifications exist **Signed by MSC and MSFC (21 of the 48 have been signed by S&ID)					

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## OPERATIONS

## DOWNEY

Boilerplate 14

All boilerplate 14 main display panels required for power-on checks were installed in the vehicle, and power-on checks were accomplished. The main batteries, battery charger, and caution and warning unit were installed.

Power-on checks of the electrical power subsystem and the communications and instrumentation (C&I) subsystems were completed, followed by installation of the C&I packages and associated thermocouples in the vehicle. C&I checks with the telemeter ground station were completed. The reaction control subsystem (RCS) relay boxes were reworked and installed.

Modification of boilerplate 14 and associated equipment to the configuration required for sequencer testing was completed. Hookup of GSE to boilerplate 14 was completed on February 8, and sequencer testing was started on February 9.

Boilerplate 22

The boilerplate 22 service module, command module, and launch escape subsystem were stacked, the command module boost protective covers were installed, and the earth landing subsystem/launch escape subsystem sequencer bench checkout was completed. The integrated GSE checkout was accomplished satisfactorily.

Checkout of the earth landing subsystem baroswitch, antenna subsystems, and earth landing subsystem/launch escape subsystem sequencer was accomplished. The electrical power subsystem power-on checks were completed satisfactorily.

Spacecraft 001

Checkout of RCS engine quad D was accomplished. Checkout of the instrumentation of engine quads A, B, and C was conducted. Leak and proof pressure test of the RCS engine quad C was accomplished.

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## WHITE SANDS MISSILE RANGE (WSMR)

Propulsion System Development Facility (PSDF)

## Test Fixture F-2

The reworked service propulsion engine, engine 0006, was installed in test fixture F-2 on January 23. The reworked radiation boot was received, and the flame shield modification was installed; then the helium pressurization package was installed. Fuel and oxidizer were circulated through their respective systems and sampled: laboratory analysis of the samples was satisfactory. A complete functional check of the propellant transfer and conditioning area was accomplished. Fuel and oxidizer tanking was completed. Functional checks of the test fixture and service propulsion engine were satisfactory.

The test firing precountdown was accomplished on February 10. Test firing 1 of test series 2 was attempted in the late afternoon after the solution of some minor problems. At 5:23 p.m. (MST) the NASA safety engineer interceded and canceled the test operation because it was after nightfall. Negotiations are under way to determine and satisfy all conditions and requirements that constrain night firing on test fixture F-2.

Test firing 1 of test series 2 was accomplished at 11:05 a.m. (MST) on February 11. The engine was shut down after 8 seconds of a scheduled 10-second firing because of a chamber pressure instrumentation malfunction in which a chamber pressure indication of 48 percent of the nominal value was obtained.

The test was repeated after replacement of the malfunctioning transducer. A successful 10-second firing was conducted on February 15. Chamber pressure data were normal during this repeat firing; however, a malfunctioning flowmeter will be replaced.

## Spacecraft 001

The leak and functional test of spacecraft 001 service propulsion subsystem was completed. Checkout of the fire detection subsystem and the rough combustion cutoff subsystem was accomplished on January 26. Modification of the flame shield boot was completed on January 27.

Circulation of the fuel and oxidizer was accomplished, and samples were taken. The analysis for contamination of the propellants was satisfactory. Oxidizer tanking was accomplished on January 31; fuel tanking was accomplished on February 1. No major leaks were encountered in either system.

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Prefire and practice firing countdown operations were conducted, but the scheduled firing with spacecraft 001 was canceled before initiation of the countdown because of an interruption of commercial power.

Test firings 1 and 1A were accomplished on February 5. Firing 1 was terminated after approximately 1.3 seconds by the rough combustion cutoff system. The flame shield boot was removed, and a thorough inspection of the spacecraft and engine was performed. Since results of the inspection were satisfactory, the boot was reinstalled. A countdown was initiated, and test firing 1A was accomplished at 3:07 p.m. Quick-look data indicated a satisfactory test firing of 10.06 seconds.

The next scheduled firing of spacecraft 001 will be conducted on 23 February.

#### FLORIDA FACILITY (FF)

##### Boilerplate 16

The launch escape subsystem (LES) was mated with the command module/launch vehicle on January 19. Test ordnance to support overall test 2 was delivered to the Kennedy Space Center on 25 January. Activation of the four pyro flight batteries was begun on February 10 to support the launch of boilerplate 16. Installation and checkout of all pyrotechnics in boilerplate 16 were completed on February 11.

##### Boilerplate 26

A review of boilerplate 26 open items was held with NASA on February 10. Buildup of the boilerplate 26 LES was started on February 16 in the pyrotechnic installation building.

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## FACILITIES

## DOWNEY

Design Engineering Inspection (DEI) Area, Building 1

The building 1 project is complete, with the exception of punch list items. The DEI mock-ups and related equipment were relocated from building 201 on January 29.

Relocation From Ferguson to Compton

The final move from Ferguson to building 343 at Compton was accomplished on the weekend of January 30. This move involved approximately 400 people, including Apollo Site Activation and Logistics.

Building 290 Addition

The structural steel construction is approximately 60 percent complete; the ground-floor slabs are about 60 percent complete; the basement walls are about 80 percent complete. The floor slab over the basement was placed on February 12. The builder is currently working to complete construction by June 15, 1965.

Building 289 Modifications, Reaction Control Subsystem

Construction is approximately 15 percent complete. The contractor has all the underground work completed, and is currently building forms for the test cell walls.

Building 318 (Engineering)

Construction of the basic building is on schedule, and is to be completed April 15. Requests for quotations and job orders are being prepared for occupancy construction, which is scheduled to start March 15, 1965, and to be completed May 15, 1965.

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APPENDIX

S&ID SCHEDULE OF APOLLO  
MEETINGS AND TRIPS



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S&ID Schedule of Apollo Meetings and Trips  
January 16 to February 15, 1965

Subject	Location	Date	Organization
System integration support, spacecraft 001	White Sands, New Mexico	January 15	S&ID, NASA
Parachute packing	El Centro, California	January 15 to 21	S&ID, USN
Simcom system tests	Cambridge, Massachusetts	January 16 to 22	S&ID, Raytheon
Simcom system tests	Cambridge, Massachusetts	January 17 to 22	S&ID, Raytheon
Prelaunch checkout schedules	Cocoa Beach, Florida	January 17 to 21	S&ID, NASA
Review, contract NAS9-150	Houston, Texas	January 17 to 19	S&ID, NASA
Design verification tests	Buffalo, New York	January 17 to February 5	S&ID, Bell
CO <sub>2</sub> measurement system meeting	Houston, Texas	January 17 to 18	S&ID, NASA
Program and review changes	Lowell, Massachusetts	January 17 to 22	S&ID, Avco
Schedule discussion and technical changes regarding redesign	Joplin, Missouri	January 18 to 24	S&ID, Eagle-Picher
Propulsion system test of spacecraft 001	White Sands, New Mexico	January 18 to 22	S&ID, NASA
Review of support manuals	Boulder, Colorado	January 18 to 21	S&ID, Beech
Flight technical panel meeting	Houston, Texas	January 18 to 19	S&ID, NASA
Flight technical system meeting	Houston, Texas	January 18 to 19	S&ID, NASA
Final review of configuration, service propulsion system	Sacramento, California	January 18	S&ID, Aerojet
Discussion of test program	White Sands, New Mexico	January 18 to 22	S&ID, NASA
Installation procedures for main parachute, review	El Centro, California	January 18 to 22	S&ID, USN
Review of scientific experiments	Houston, Texas	January 18 to 20	S&ID, NASA
Finalize GSE and Block 1 GSE	Houston, Texas	January 17 to 19	S&ID, NASA

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S&ID Schedule of Apollo Meetings and Trips  
January 16 to February 15, 1965 (Cont)

Subject	Location	Date	Organization
Test readiness review	Las Cruces, New Mexico	January 19	S&ID, NASA
NPDS meeting	Palo Alto, California	January 19	S&ID, NASA
Test readiness review for spacecraft 001	Las Cruces, New Mexico	January 19	S&ID, PSDF
Witness acceptance tests	Santa Clara, California	January 19 to 20	S&ID, Explosive Technology
Temperature control coating evaluation meeting	Houston, Texas	January 19 to 20	S&ID, NASA
Tests and review	Sacramento, California	January 19 to 21	S&ID, Aerojet
Failure of RCS pres- sure vessels during DVT review	Buffalo, New York	January 19	S&ID, Bell
Test procedure review	Sacramento, California	January 19 to 21	S&ID, Aerojet
Spacecraft 001 support for test	White Sands, New Mexico	January 19 to 21	S&ID, NASA
Preparation of OCP documents by EDP	Houston, Texas	January 20 to 21	S&ID, NASA
EMI test plan evaluation	Kalamazoo, Michigan Lima, Ohio	January 20 to 29	Westinghouse, S&ID
Crew safety system panel meeting	Houston, Texas	January 20 to 21	S&ID, NASA
SPS status review meeting	Houston, Texas White Sands, New Mexico	January 20 to 23	S&ID, NASA
Review status of VHF omni antennas	Bethpage, L. I., New York	January 20 to 24	S&ID, Grumman
Docking vision and lighting simulation meeting	Houston, Texas	January 20 to 22	S&ID, NASA
Support of preparation of spacecraft 001	Las Cruces, New Mexico	January 20 to February 5	S&ID, NASA
Test readiness accept- ance panel meeting	Las Cruces, New Mexico	January 21 to 23	S&ID, NASA

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S&ID Schedule of Apollo Meetings and Trips  
January 16 to February 15, 1965 (Cont)

Subject	Location	Date	Organization
Coordination meeting, service module RCS quad kit	Houston, Texas	January 21 to 22	S&ID, NASA
Test readiness assurance panel for spacecraft 001	White Sands, New Mexico	January 21 to 23	S&ID, NASA
Relocation of parachute retention parts on boilerplate 19	El Centro, California	January 22 to 23	S&ID, USN
Modification of boilerplates 19 and 6A	El Centro, California Newberry Park California	January 22	S&ID, USN, Northrop-Ventura
Design coordination board meeting	Bethpage, L. I., New York	January 23 to 23	S&ID, Grumman
Design coordination board meeting	Bethpage, L. I. New York	January 24 to 26	S&ID, Grumman
Solder and crimp specification	Subcontractor sites	January 24 to February 3	S&ID, various subcontractors
Design verification testing of propellant utilization and gauging subsystem	Tarrytown, New York	January 24 to February 5	S&ID, Simmonds
On-site technical representation	Tullahoma, Tennessee	January 24	S&ID, NASA
Block II design of EPS and ECS radiators, discussion	East Alton, Illinois Richmond, Virginia	January 25 to 29	S&ID, Olin Metals, Reynolds Metals
Testing of DVT units	Kalamazoo, Michigan	January 25 to 28	S&ID, National Water Lift
EPS radiator for Block II configuration discussion	East Alton, Illinois Richmond, Virginia	January 25 to 29	S&ID, Olin Metals, Reynolds Metals
MILA/KSC facilities activation plan, revisions	Cocoa Beach, Florida	January 25 to 29	S&ID, NASA
AMS/MSCC trajectory interface task group meeting	Houston, Texas	January 25 to 27	S&ID, NASA

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S&ID Schedule of Apollo Meetings and Trips  
January 16 to February 15, 1965 (Cont)

Subject	Location	Date	Organization
Review performance of qualification test program	Elkton, Maryland	January 25 to 28	S&ID, Thiokol
Monitoring and evaluation of technical progress pertaining to attainment of stable injectors	Sacramento, California	January 25 to February 6	S&ID, Aerojet
Block II SCS, technical support	Minneapolis, Minnesota	January 25 to February 5	S&ID, Honeywell
Lunar TV camera interface meeting	Houston, Texas	January 25 to 28	S&ID, NASA
Block II Government-furnished equipment TV camera coordination meeting	Houston, Texas	January 25 to 27	S&ID, NASA
System verification test program	Minneapolis, Minnesota	January 26 to February 5	S&ID, Honeywell
Structural design spacecraft interfaces	Bethpage, L. I., New York	January 26 to 27	S&ID, Grumman
Documentation requirements, review	Subcontractor sites	January 26 to 31	S&ID, Simmonds, Air Products and Chemicals, Nordon Division-UAC
Review motorola test results, MSFN S-band and Block II S-band	Houston, Texas	January 26 to 29	S&ID, NASA
Electrical circuit design development	Lima, Ohio	January 26 to 29	S&ID, Westinghouse
Design engineering inspection relative to instrumentation mod-kit for spacecraft 009 and 011	Tulsa, Oklahoma	January 26 to 29	S&ID, NASA
Toggle switch procurement specification meeting	Freeport, Illinois	January 26 to 29	S&ID, Micro-Switch
Launch boost test meeting	Houston, Texas	January 26 to 27	S&ID, NASA
Structural test ICD meeting (spacecraft-lunar excursion module adapter)	Tulsa, Oklahoma	January 26 to 28	S&ID, NASA

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S&ID Schedule of Apollo Meetings and Trips  
January 16 to February 15, 1965 (Cont)

Subject	Location	Date	Organization
Technical coordination meeting, schedule improvement for spacecraft 009	Moline, Illinois	January 27	S&ID, Eagle
Discussion of manufacturing and delivery	Boulder, Colorado	January 27 to 29	S&ID, Beech
Preliminary program plan discussion	Houston, Texas	January 27 to 29	S&ID, NASA
Block II coordination and discussion of PSA thermal test results (G&N thermal mockups)	Cambridge, Massachusetts	January 27 to 29	S&ID, MIT
Review main parachute status	Houston, Texas	January 27 to 28	S&ID, NASA
Test readiness assurance panel meeting	White Sands, New Mexico	January 28 to 29	S&ID, NASA
Cost proposal discussion	Sacramento, California	January 28 to 29	S&ID, Aerojet
Resolution of Block II, PSA, AGC, CDU, and PIPA mechanical interface	Cambridge, Massachusetts	January 27 to 29	S&ID, MIT
Test readiness review meeting on spacecraft 001	Las Cruces, New Mexico	January 29 to 30	S&ID, NASA
Review of DVT test procedures and test setups	Virginnes, Vermont Tarrytown, New York Roanoke, Virginia	January 31 to February 7	S&ID, Simmonds
Technical details and support of updata link equipment	Scottsdale, Arizona	January 31 to February 5	S&ID, Motorola
Boilerplate 23A modification coordination meeting	Las Cruces, New Mexico	January 31 to February 1	S&ID, NASA
Spacecraft 2TV-1 negotiations	Houston, Texas	February 1 to 3	S&ID, NASA
MIT G&N meeting and checkout panel meeting	Houston, Texas	February 1 to 3	S&ID, MIT, NASA
Coordination of test plans and test data with Downey personnel	El Centro, California	February 1 to 28	S&ID, USN

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S&ID Schedule of Apollo Meetings and Trips  
January 16 to February 15, 1965 (Cont)

Subject	Location	Date	Organization
Boost protective cover, briefing	Houston, Texas	February 1 to 3	S&ID, NASA
Subcontractor management coordination meeting	Minneapolis, Minnesota	February 2 to 5	S&ID, Honeywell
Discussion of thrust vector control portion, Block II	Minneapolis, Minnesota	February 2 to 5	S&ID, Honeywell
Apollo command module tests	Newark, New Jersey	February 2 to 5	S&ID, Stevens Institute
Support spacecraft 001 for propulsion subsystem testing	Las Cruces, New Mexico	February 2 to 4	S&ID, NASA
Parachute subsystem tests	El Centro, California	February 2	S&ID, USN
Discussion of AMPTF	Bethpage, L.I., New York	February 2 to 4	S&ID, Grumman
Discussion regarding updata link real-time commands on Block I spacecraft	Houston, Texas	February 2 to 3	S&ID, NASA
Discussions of fuel cell test results	E. Hartford, Connecticut	February 2 to 4	S&ID, Pratt & Whitney
Program review meeting	Tarrytown, New York	February 3 to 5	S&ID, Simmonds Precision
Acceptance data package, meeting	Houston, Texas	February 3 to 4	S&ID, NASA
Guidance and control coordination, meeting	Houston, Texas	February 3 to 5	S&ID, NASA
Routing inspection trip	Goleta, California	February 2	S&ID, General Motors
Resolve Block I and II S-band acquisition procedures	Houston, Texas	February 4 to 5	S&ID, NASA
Review char sensor qualification program	Sunnyvale, California	February 4	S&ID, Thermatest
Clarification on micro-miniaturization and direction for Block II design base	Minneapolis, Minnesota	February 4 to 5	S&ID, Honeywell

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S&ID Schedule of Apollo Meetings and Trips  
January 16 to February 15, 1965 (Cont)

Subject	Location	Date	Organization
Witness acceptance test procedures of central timing equipment	Rolling Meadows, Illinois	February 4 to 9	S&ID, General Time
Review and discussion of NASA docking simulation	Houston, Texas Dayton, Ohio	February 7 to 10	S&ID, NASA, USAF
Coordination of GSE-SPS checkout requirements	Tarrytown, New York Burlington, Vermont	February 7 to 12	S&ID, Simmonds
Zero gravity flight tests	Dayton, Ohio	February 7 to 12	S&ID, NASA, USAF
Contract award coordination meeting	Phoenix, Arizona	February 8 to 9	S&ID, Motorola
Discussion on Block II service module	Tulsa, Oklahoma	February 9 to 11	S&ID, NASA
Flight testing conference	Huntsville, Alabama	February 14 to 17	S&ID, NASA

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